CETRA 2018

5th International Conference on Road and Rail Infrastructure
17–19 May 2018, Zadar, Croatia

Road and Rail Infrastructure V

Stjepan Lakušić – EDITOR

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PLATFORM INFRASTRUCTURE – INFLUENCE ON PASSENGER BEHAVIOUR

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Abstract

Passenger distribution along the platform has a significant influence on passenger exchange time and thus on hold time and operating quality. This shows that most passengers orient themselves to the deboarding situation, which leads in part to a very pronounced unequal distribution along the platform. This in turn results in the overloading of individual doors and significantly extended passenger exchange times.

1 Introduction

Due to the disproportionate increase in passenger exchange time, an uneven distribution of passengers along the platform in long-distance travel has an even stronger influence on hold time than in local transport. Due to station density, however, the influences of unequal distribution must under no circumstances be neglected in local transport. In long-distance transport, positioning on the platform depends primarily on whether or not travellers have a seat reservation. Subsequently, the selected coach class also influences the location of the positioning regardless of possible reservations. On the so-called "coach position indicators", it is possible to read off on the platform before the train arrives where the coach in which the reserved seats are located or where coaches of the selected coach class or the dining coach will come to a stop. This then has a corresponding effect on the waiting position on the platform. In the case of available seat reservations, it is apparent that in many cases the reservations automatically assigned by the booking system per station are not evenly distributed over the entire train, but often from one station reservations in only two of three coaches are made. Particularly on peak travel days with increased passenger volume, this inevitably leads to an artificially generated and easily avoidable overloading of individual doors with correspondingly long hold times for the entire train. Especially in local transport but also to some extent in long-distance transport, there are significant factors influencing the distribution of passengers along the platform resulting from the platform infrastructure and the platform facilities. The unequal distribution along the platform inevitably leads to one door, the so-called "critical door", having the highest proportion of passengers boarding or deboarding the train. As a rule, the passenger exchange at this door takes longer than at other doors, which makes this "critical door" a decisive factor in the entire station stop. Regarding the distribution of passengers, there are the following influencing parameters on the infrastructure side:

2 Entrances and Exits

The entrances and exits have the most influence on passenger distribution. In general, it can be said that local and system-knowledgeable passengers know exactly at which door along a train they will find the shortest path to the exit at their arrival station. In the sense of overall

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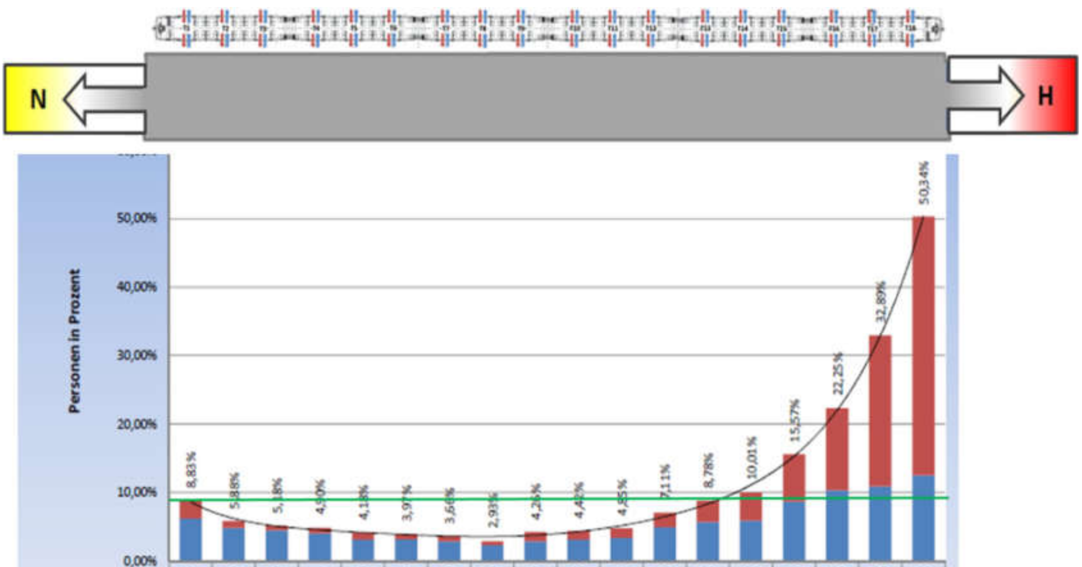
travel time optimization, a possible waiting time at the platform is therefore used to go to the area where boarding is expected to provide the shortest path to the exit after deboarding. The longer the interval times between trains, the higher the probability is of having to wait for the arriving train and therefore the more frequently passengers board at the above mentioned door. If the train interval times are short, the likelihood increases that a majority of the passengers will not have enough time to reach the desired door after arriving on the platform. In this case, it is shown that the position of the platform entrances have an increasing influence on passenger distribution. Entrances and exits can be divided into three categories according to their expected passenger frequency:

- main exit (H);
- middle exit (M);
- secondary exit (N).

Main exits in transfer stations usually lead to the most direct way to other (main) means of transport such as further underground trains or to several tram and bus lines. Main exits can also be exits to commercial streets or shopping centres. In any case, these are exits with a high volume of people. Middle exits can be exits to the surface or to other means of transport, which however, have a noticeably lower volume of people compared to main exits. Secondary exits are exits in a station that are frequented by only a few people. Generally, the category of exits may vary throughout the day. For example, during peak time in the morning the main traffic directions may be opposite to those during evening peak time. This means that in transfer stations, main exits in the morning can become middle exits in the evening and vice versa. Figure 1 shows an example of a station with a secondary exit (N) and a main exit (H) with direct connection to other main means of transport. It depicts the distribution of boarding and deboarding passengers along the entire train. It shows that especially the deboarding passengers orient themselves to both exits. Alone at that door which is closest to the main exit, over a third (37 %) of all passengers deboard. Nearly 72 % of all deboarding passengers pass through those three doors that are closest to the main exit. Further along the train, the proportion of deboarding passengers is to some extent very low (under 4 %) and then increases somewhat towards the secondary exit.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
passengers deboarding	2,62%	0,99%	0,65%	0,81%	0,97%	0,75%	0,74%	0,60%	1,35%	1,22%	1,45%	2,12%	3,05%	4,07%	6,90%	11,92%	22,00%	37,80%
Passengers boarding	6,21%	4,89%	4,53%	4,09%	3,21%	3,22%	2,92%	2,33%	2,91%	3,20%	3,40%	4,99%	5,73%	5,94%	8,67%	10,33%	10,89%	12,54%
total	8,83%	5,88%	5,18%	4,90%	4,18%	3,97%	3,66%	2,93%	4,26%	4,42%	4,85%	7,11%	8,78%	10,01%	15,57%	22,25%	32,89%	50,34%

Figure 1 Boarding and deboarding passengers at a station with one-sided main exit (Eigner)

The behaviour of the boarding passengers is different. Certainly here also a distribution toward both entrances can be seen, this is however not as pronounced as with the deboarding passengers. However, still approx. a third of all passengers (34 %) board at the three doors closest to the main entrance. The reason for the more even distribution is to be found in the fact that the stations in the following illustrated example have different arrangements of the main exits. There are respectively two stations with the main exit at the same place, two stations with the main exit at the other end and one station with a main exit more in the middle. The green line shown in Figure 1 depicts the average of all passengers boarding and deboarding in the station in relation to in each case one door and represents an ideal case of even distribution along the entire train. At the same time, it shows that door 18 in the stated example is more than five times as heavily frequented as the average!
Figure 2 shows the example of a platform with two main exits arranged approximately at the quarter points. Here too it shows a distribution towards the exits with both peaks exactly at the doors closest to the respective exit.

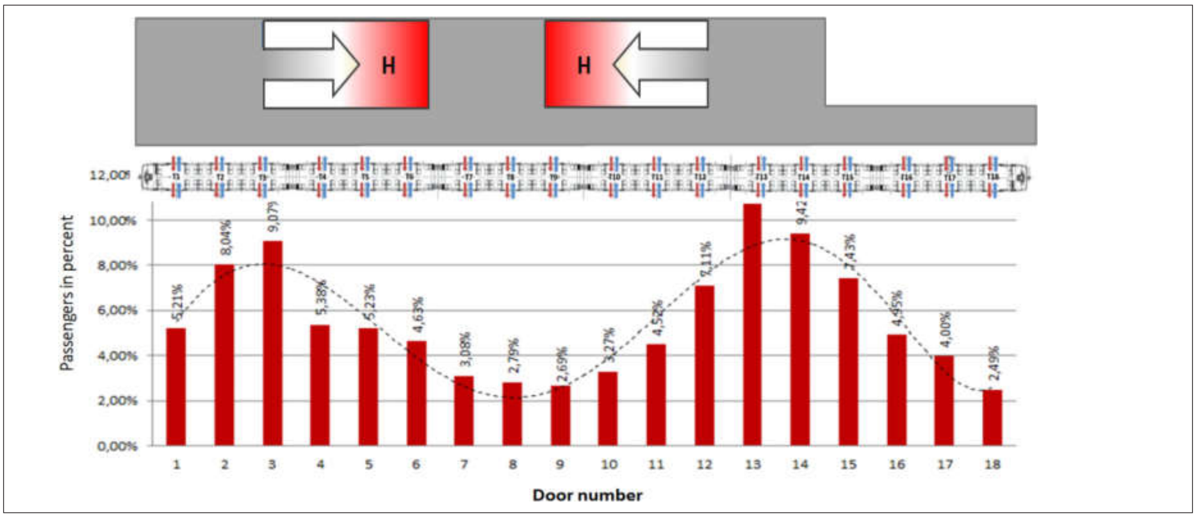


Figure 2 Deboarding passengers at a station with two main exits inserted on the platform (Eigner)

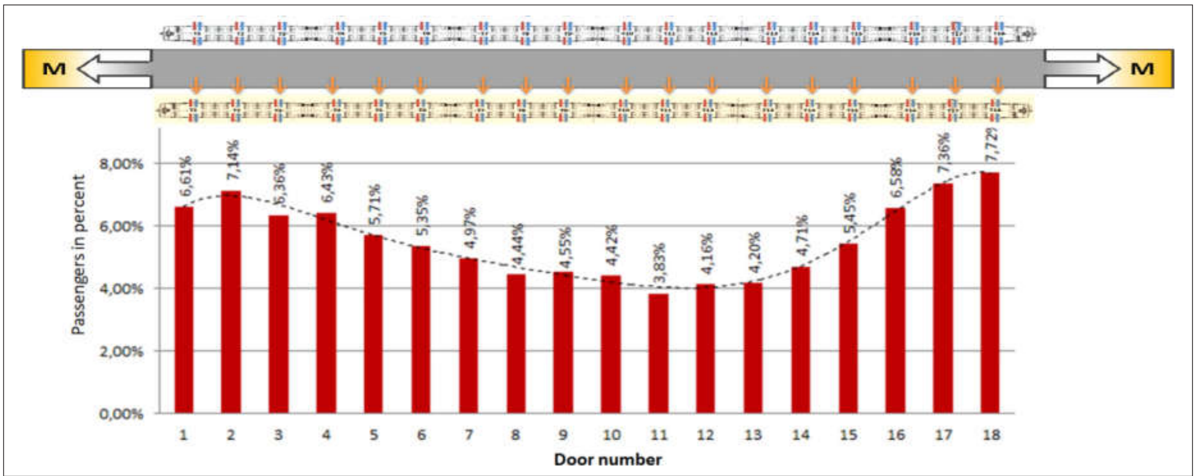


Figure 3 Distribution of deboarding passengers with same platform change of trains between two underground lines and additionally two middle exits on the platforms (Eigner)

Figure 3 shows an example of a special case. Here on both platforms there are two equivalent middle exits. The “main exit” in this case is the platform itself because a same platform transfer between two underground lines takes place. It shows the following flow: there is in each case an increase in the number of deboarding passengers toward the two middle exits.

Nevertheless, the flow along the entire platform is relatively balanced. The ratio is less than 2:1 between the most and the least frequented doors. The increase towards the two exits is encouraged as well by the fact that the exits at the adjacent stations of each subway line into which it is possible to transfer, are also located at the respective platforms. Thus, when changing trains on the same platform, already in boarding the first train, knowledge about the nearest exit to the connecting train also influences deboarding behaviour.
If there is only one main exit and if this is placed in the middle of the platform and not at the end of the platform, there is already a much better passenger distribution (see Figure 4).

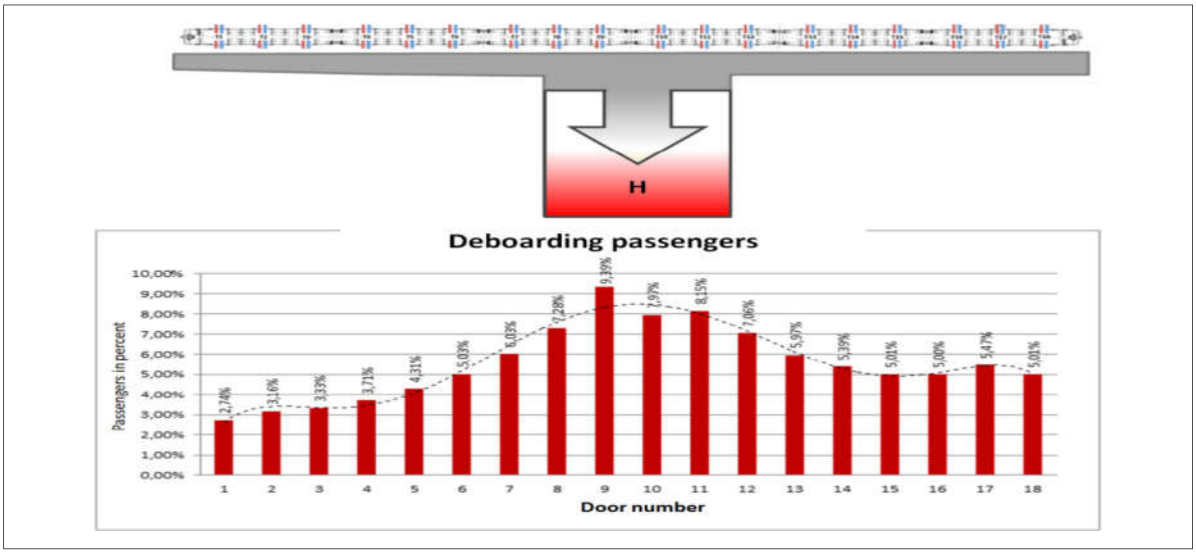


Figure 4 Distribution of the deboarding passengers with a centrally arranged main exit (Eigner)

Figure 5 shows a comparison of different types of platforms with regard to the exits and their effect on the degree of overcrowding in terms of deboarding passengers at the most frequented door, the so-called "critical door". The factor 1 means the ideal condition when all doors are evenly used to capacity. The lower the "overcrowding factor", the more uniformly the doors are occupied and the lower the negative influence on hold time due to uneven passenger distributions. The case with a same platform transfer to another underground line with an additional two exits with moderately heavy use shows the lowest level of overcrowding. Good values are further achieved when the main exits are centrally arranged on the platform or if they are divided into two exits but also not at the platform end. The worst distribution values and thus the highest values for overcrowding at the critical door are obtained if the main exit is at the end of the platform or there is only one exit at all at the end of the platform.

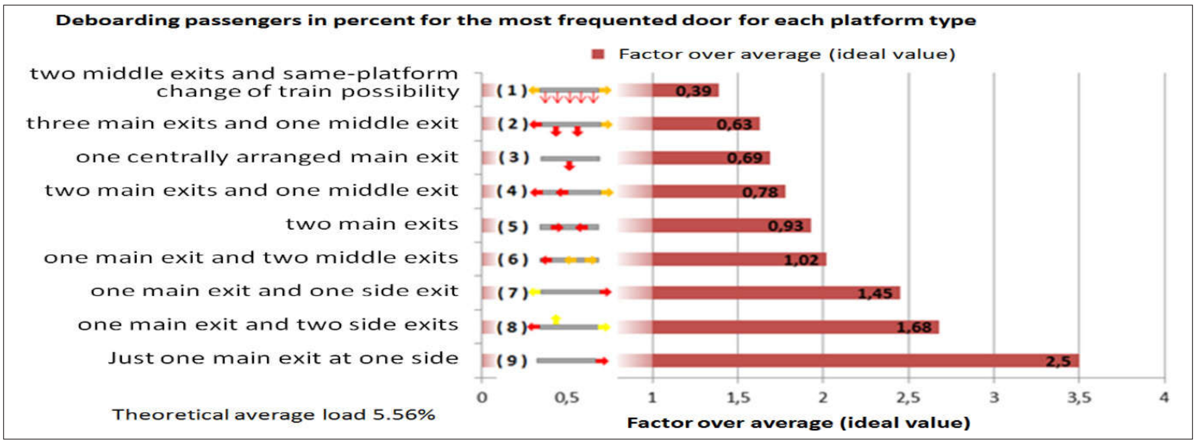


Figure 5 Comparison of the most frequented door per platform type (Eigner)

3 Passenger distribution of boarding passengers

If passengers have sufficient time before the arrival of the train and if they are local and system-knowledgeable as well, they usually go to the area where they expect the nearest exit at the destination station. In the following cases, passengers do not however use the boarding door depending on the nearest exit at the arrival station. Passengers who are location or system-knowledgeable are most likely to choose those doors which are close to the platform entrance that they have used.

In the event of overloading at a door, passengers in part switch to nearby doors. Whereby, as a rule only the two adjacent doors to the left or right are chosen. This also only happens when passengers are boarding or deboarding at those doors and it is thereby ensured that by switching to the nearby doors they do not in the end miss the train. Otherwise, they wait at the overloaded door until boarding is possible.

In the end, there are still those people who reach the platform only when the passenger exchange is already in process. In the case of railway long-distance transport, the stopover can take several minutes, in which case travellers often go to the desired door. The fact that the train is already at the platform causes many passengers have an uneasy feeling that the train is about to depart. These passengers board the train early and move on through train.

In local transport, especially in urban local transport, hold times are limited to a possible minimum. Here, the fact that a train is already at the platform means that after reaching the platform, the train is boarded according to the shortest way to the train. This usually happens at each door which can best be reached from the platform entrance. In particular, those people who reach the platform after an already completed passenger exchange and still want to reach the train quickly, select that door which can most quickly be reached from the entrance without any further changes of direction.

The above mentioned circumstances mean that in addition to a noticeable correlation between deboarding passengers and the proximity to the exit in the destination station, there is also an accumulation of boarding passengers near the entrances. Because of those people who enter the train at the last moment before or during the servicing of the train, there are also load peaks from boarding passengers especially at the doors which can best be reached from the platform entrance.

Figure 6 illustrates in this regard the distribution of passengers along a platform depending on platform entrances. In the specific case, an example is visualized in which there is a main entrance (H) and two middle entrances (M). Likewise, from the same figure the influence of the architectural infrastructure on passenger distribution is shown. To the right of the main entrance there are regularly spaced columns on the platform. It can be seen that in this area despite a platform width similar to the area to the left of the main entrance, on average 50 % to 80 % fewer passengers are waiting per door than in the area to the left. Furthermore, it can be seen that as the platform width increases in an otherwise comparable situation (regularly spaced columns), the number of passengers per door increases again.

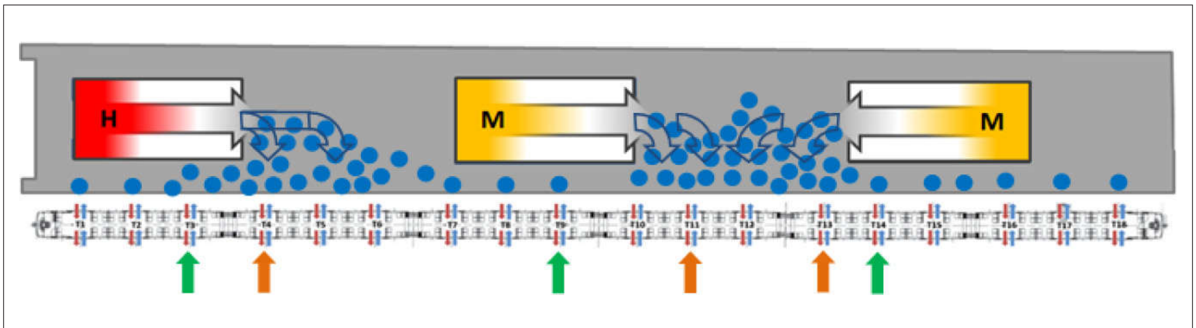


Figure 6 Passenger flow depending on the access situation (Eigner)

Figure 7 illustrates the peaks at the most reachable door from the main entrance (H), (door 4 from the left).

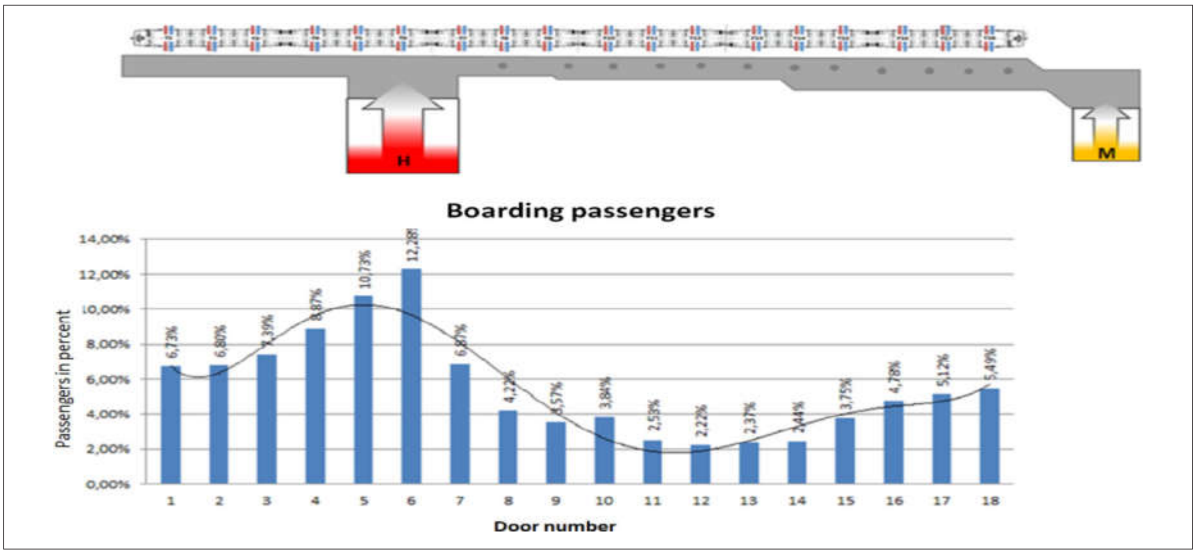


Figure 7 Impact of architectural bottlenecks/obstacles on passenger distribution on the platform (Eigner)

4 Further contributing factors to the passenger distribution on the platform

In addition to the entrances and exits as well as different platform widths or fixtures such as columns (see above), there are other contributing factors that influence passenger distribution along a platform. An accumulation of waiting passengers can be found in information areas on the platform such as information monitors but also news and advertising screens behind the platforms. There is also a general accumulation by seating areas. It can be observed here, however, that the age distribution of seated passengers depends on the distance to the main entrance. It should be noted that seating areas closer to a main entrance tend to be used by older passengers and in comparison seating areas that are farther away are more often used by younger passengers (see Figure 8). This suggests that elderly people on the platform are more likely to remain close to the entrance because of the shorter distance.

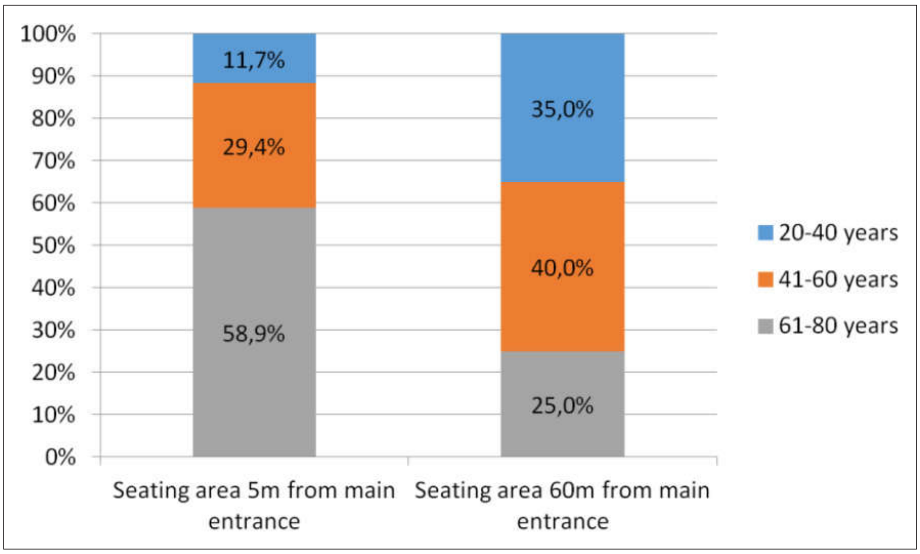


Figure 8 Age distribution of seated passengers depending on the distance to the main entrance (Delac)

Furthermore, the investigation shows that the seating areas along a platform are evenly occupied even if the passenger occupancy along the platform is in part highly varied. This means that passengers will also go to less occupied areas of the platform if free seats can still be found there. These observations, however, are based on inner-city suburban railways, where slightly longer waiting times are expected compared to the underground.

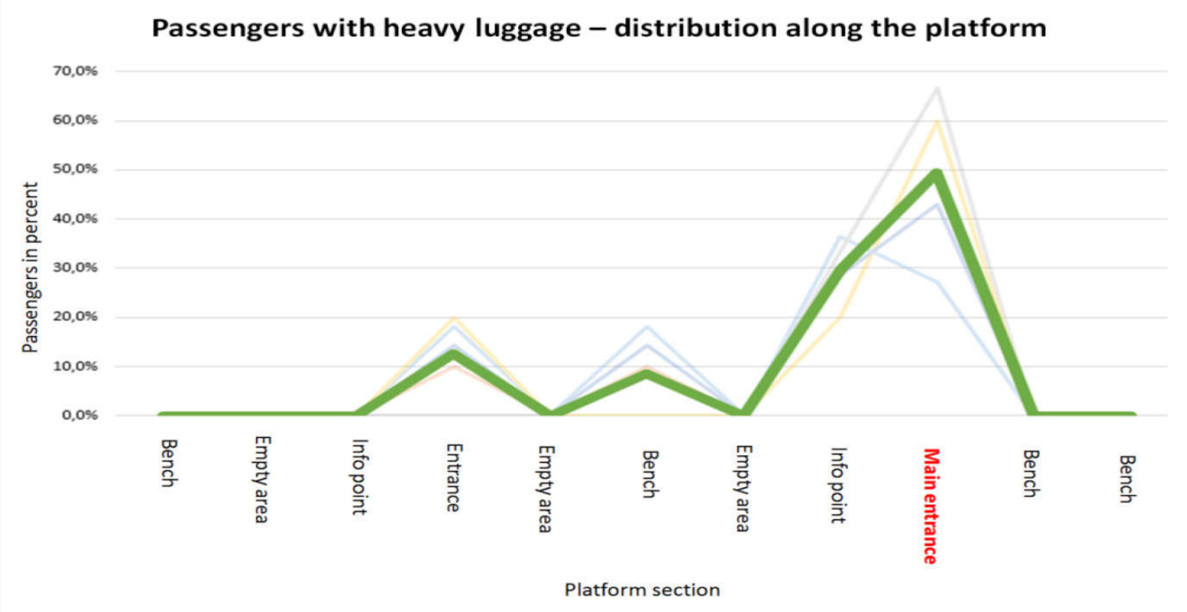


Figure 9 Distribution of passengers with heavy luggage along the platform (Delac)

Passengers with heavy luggage, who are often not local or system-knowledgeable (e.g. tourists), are often located with above average frequency in the immediate vicinity of the platform entrance, which leads to the conclusion that because of the luggage they would like to cover the shortest distance possible (See Figure 9).

5 Conclusion

Significant influences on operating procedures can ultimately be passengers who are waiting on the platform and unevenly distributed along the entire platform. Particularly with urban transport networks such as undergrounds, it is shown that the overwhelming majority of passengers are local and system-knowledgeable and already when boarding use that door by which when deboarding they expect to find the shortest path. This behaviour is only suspended if the time until the departure of the train is no longer sufficient to go to the desired door or if people are not local or system-knowledgeable. Likewise, there are influences from infrastructure facilities such as information areas and seating areas which tend to lead to an accumulation of waiting passengers. However, the most pronounced influencing factor is the deboarding behaviour of passengers. Along transport lines, in planning concerning this matter, it should be considered that on each platform there are at least two exits which do not lie exactly at the respective ends. Exits with the widest possible design approximately at quarter points on the platform or at third points with additional exits on the platforms lead to a relatively even distribution of passengers. Along a line, it should as well be ensured that the exits do not lie precisely at the same places at all stations, above all those with a high passenger volume. A slight variation in the position of the exits along a line in the progressing stations inevitably results in a significantly more balanced passenger distribution along the platform with significantly shorter hold times. This is an advantage not only for punctual and smooth operation but also with regard to energy consumption, because avoiding regular delays must not be achieved through reducing the respective possible maximum speeds.

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